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( Reaffirmed 2006 )

# *Indian Standard*

# SPECIFICATION FOR CATHETOMETER

( First Reprint MAY 1983 )

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INDIAN STANDARDS INSTITUTION
MANAK BHAVAN, 9 BAHADUR SHAH ZAFAR MARG
NEW DELHI 110002

Gr 3

*July* 1965

# *Indian Standard*
# SPECIFICATION FOR CATHETOMETER

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# *Indian Standard*

# SPECIFICATION FOR CATHETOMETER

## 0. FOREWORD

**0.1** This Indian Standard was adopted by the Indian Standards Institution on 18 June 1965, after the draft finalized by the Optical and Mathematical Instruments Sectional Committee had been approved by the Mechanical Engineering Division Council.

**0.2** A cathetometer is an instrument used for measuring vertical distances. It essentially consists of an accurately graduated scale held in a vertical position and a reading telescope which may be moved up and down. A vernier attached to the reading telescope facilitates the accurate determination of the distance which the telescope has travelled vertically.

**0.3** The figures given in this standard are only illustrative and the design details of instruments may vary from manufacturer to manufacturer. For allowing the manufacturers to develop and improve their designs, only the essential performance requirements of the cathetometers have been dealt with in this standard.

**0.4** For the purpose of deciding whether a particular requirement of this standard is complied with, the final value, observed or calculated, expressing the result of a test, shall be rounded off in accordance with IS : 2-1960*. The number of significant places retained in the rounded off value should be the same as that of the specified value in this standard.

## 1. SCOPE

**1.1** This standard specifies the requirements of cathetometers having a vertical scale and vernier with a fine adjustment and mainly used in the laboratory for measurement of distance between two points in a vertical plane with the help of a sighting telescope.

## 2. SIZES

**2.1** Cathetometers shall be of two sizes, that is, 500 mm and 1 000 mm effective range.

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*Rules for rounding off numerical values ( *revised* ).

## 3. TERMINOLOGY

**3.0** For the purpose of this standard, the following definitions shall apply ( *see* Fig. 1 and 2 ).

**3.1 Base** — The horizontal platform on which the vertical column is mounted.

**3.2 Vertical Column** — A pillar erected vertically on the base of the instrument having main scale and guideways for the carriage.

**3.3 Carriage** — The part which slides along the vertical column and carries the vernier and reading telescope.

**3.4 Vertical Axis** — The axis about which the vertical column revolves.

**3.5 Line of Sight** — It is the axis of the reading telescope.

## 4. GENERAL REQUIREMENTS

**4.1** The cathetometer shall be so designed that the vertical column shall rotate about its axis. The instruments may be provided with a base graduated in degrees with a suitable index mark.

**4.2** A suitable fixing arrangement shall be provided to clamp vertical column to the base or frame to prevent its rotation during working.

**4.3** The base shall be provided with three levelling screws which should be sufficiently strong to carry the load of the instrument.

**4.4** A circular bubble shall be provided on the base to enable quick levelling of the instrument.

**4.5** The carriage shall be so designed that it may be locked in any desired position on a vertical column. It shall also be capable of sensitive adjustment by a fine motion screw when locked.

**4.6** The frame of the instrument shall be rigid and so designed as to resist any flexure or vibration due to handling or otherwise.

## 5. FUNCTIONAL REQUIREMENTS

**5.1** The minimum focusing distance of the telescope shall be not more than one metre.

**5.2** The sensitivity of the linear bubble of telescope shall be not less than 30 seconds per 2 mm. The sensitivity of circular bubble attached to base shall be 10 minutes per 2 mm.

**5.3** The least count of the vernier shall be 0·01 mm for 500 mm effective range and 0·02 mm for 1 000 mm effective range.

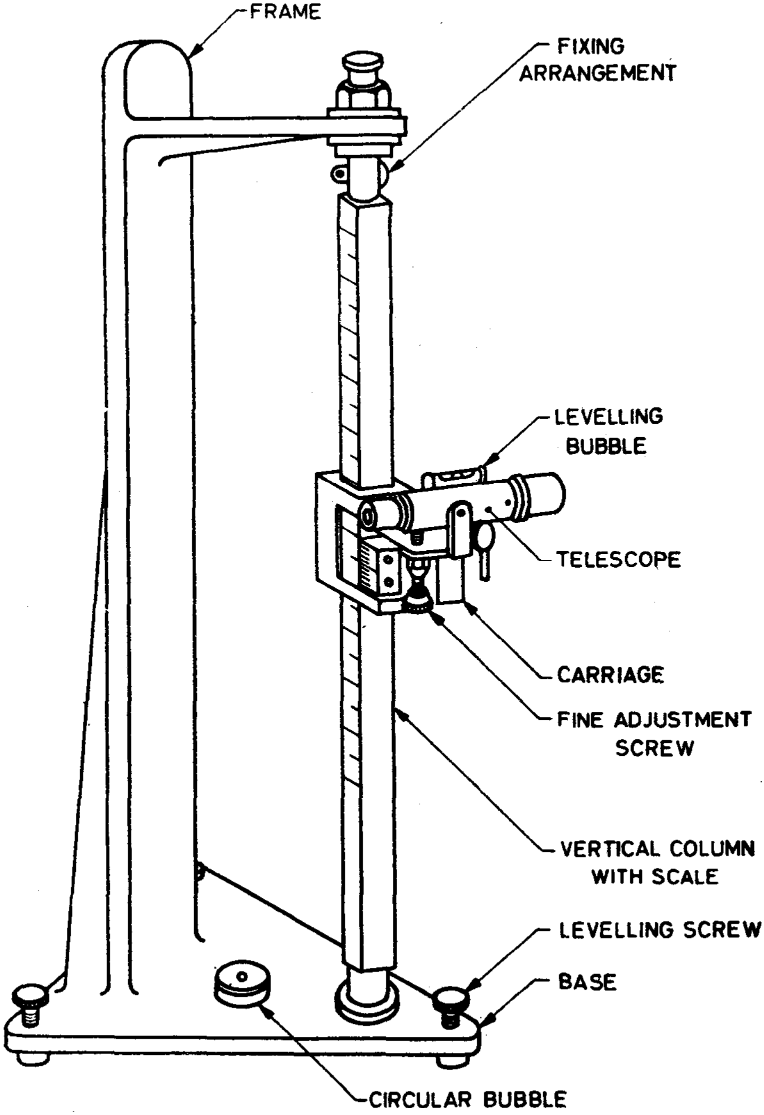

FIG. 1 NOMENCLATURE FOR SINGLE-COLUMN CATHETOMETER

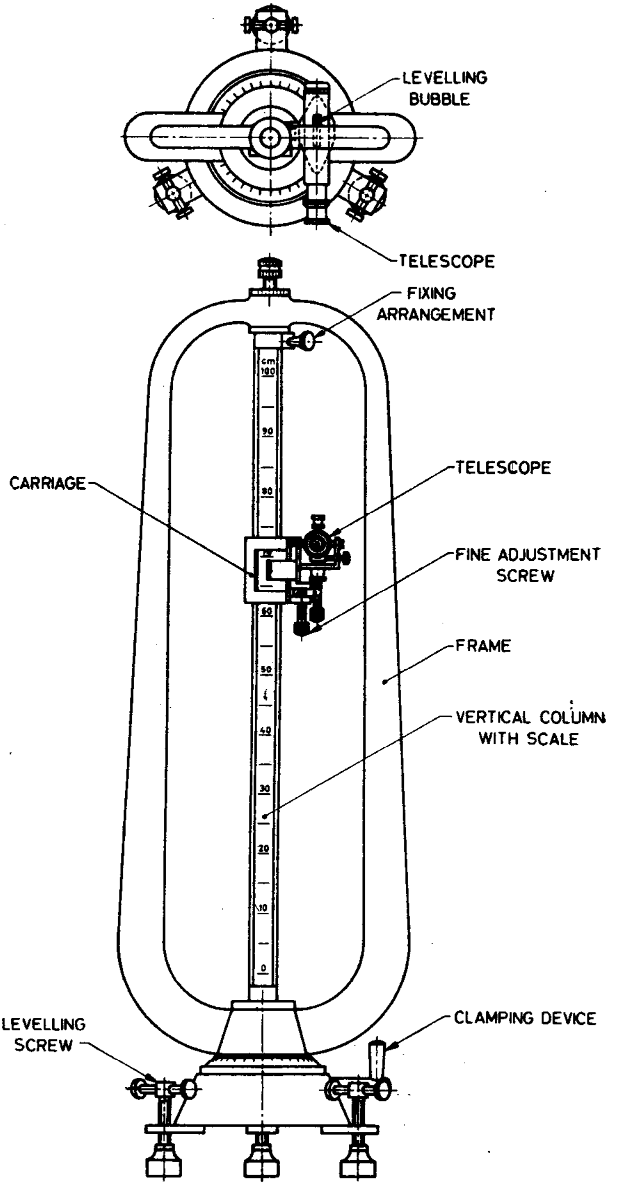

FIG. 2 NOMENCLATURE FOR DOUBLE-COLUMN CATHETOMETER

**5.4** The error between any two graduations in the scale shall not exceed 0·01 mm for 500 mm effective range and 0·02 mm for 1 000 mm effective range at 27°C.

**5.5** The carriage carrying telescope should have a fine tilting adjustment so as to enable setting of the line of sight in horizontal position.

**5.5.1** A sensitive level shall be provided on the telescope to make the line of sight horizontal.

**5.6** The telescope shall have 5× angular magnification and 20 mm clear aperture of the objective, with a minimum of 5° field of view.

**5.7** The optical axis of the telescope shall be within 60 mm of the plane of scale.

**5.8** The adjustment of perpendicularity of the vertical column to the base shall be carried out with care in order to make the cathetometer measure accurately.

**5.9** The parts of the column which form the guideways for the carriage shall be straight along their length to one minute of arc.

**5.10** The axis about which the telescope is tilted shall lie within 5 mm of the plane of scale.

**5.11** When the vertical column is rotated, its axial movement shall not exceed 0·01 mm.

**5.12** When the base is rotated in its mount, the axial movement of the vertical column due to the rotation of the base shall not exceed 0·01 mm.

## 6. MATERIALS

**6.1** The vertical scale and vernier shall be made from suitable corrosion-resistant materials having coefficient of linear expansion not greater than 0·000 020 per degree Celcius.

**6.2** The materials for optical components shall be according to IS : 988-1959* and IS : 1400-1960†.

**6.3** Material for bubble shall be in conformity with IS : 1632-1960‡.

**6.4** Material for levelling screws shall be brass.

**6.5** Other materials used for the manufacture of components of cathetometers shall be strong, of good quality and free from flaws and defects.

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*General requirements for optical components.

†Specification for optical glass.

‡Specification for bubbles.

## 7. WORKMANSHIP AND FINISH

**7.1** The painting and plating of the different parts shall be of good quality so as to resist corrosion and wear.

**7.2** The parts which are plated shall have a high degree of finish.

## 8. TESTS

**8.1 Telescope** — The telescope shall be tested for magnification, field of view, resolving power and definition according to IS : 2754-1964*.

**8.1.1** *Magnification* — Magnification may also be tested without detaching the telescope from the cathetometer by viewing a chart placed at a suitable distance with alternate black and white stripes, directly and through the telescope. The ratio of the number of divisions seen directly to the number coinciding as seen through the telescope gives the magnification.

**8.1.2** *Field of View* — Field of view may be measured on the cathetometer itself by focusing the telescope on a test object at a suitable distance and viewing either end of the field alternately when the column is rotated.

**8.2 Alignment of the Base and Telescope** — The base shall be set horizontal by means of the levelling screws attached to the base with the help of the circular bubble. The bubble on the telescope shall then be so adjusted that the air bell comes on the centre of its run. The vertical column shall now be rotated through a complete revolution. The bubble on the telescope shall remain unaltered.

**8.3 Verticality of the Column** — The verticality of the column scale with respect to the base is tested as follows:

a) When the design is such that the column and the base may be rotated independently, a scale shall be placed at a suitable distance from the cathetometer and the telescope focused on a definite mark on the scale without parallax. The vertical column is then rotated through some angle ( about 10° ) and locked in position. The central pillar carrying the main scale alone is released and rotated till the scale is again in view. The telescope shall then focus on to the same mark on the scale. Otherwise, the pillar carrying the scale is not vertical. The maximum permissible error determined in this manner shall be equal to half the least count.

b) When the design of cathetometer is such that the column alone may be rotated but not the base, an auxiliary plummet

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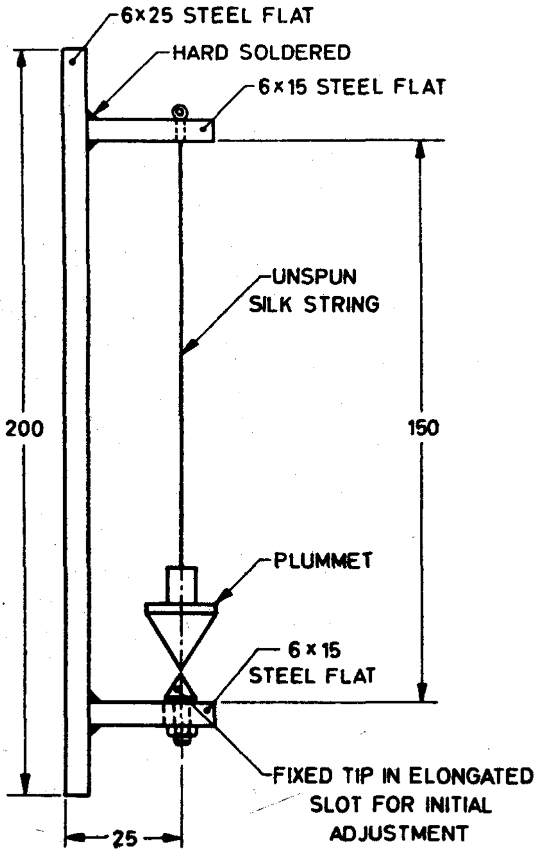
*General requirements for optical instruments.

( *see* Fig. 3 ) shall be used on the flat portion of the column ( on the side of the scale ) at various positions, and the column rotated. The tip of the plummet shall remain in alignment in all the positions.



All dimensions in millimetres.

FIG. 3 AUXILIARY PLUMMET

**8.4 Graduated Circle** — The graduated circle shall be tested by focusing the telescope on two wires which are 5° apart with respect to the telescope ( distance of the cathetometer having been adjusted initially). This test is repeated releasing the central pillar and bringing different parts of the circular scale for measurement.

**8.5 Vertical Scale** — Accuracy of the vertical scale shall be tested by measuring the distance between two marks on a gauge bar at different positions of cathetometer scale. The same length as measured at any section on the cathetometer shall not vary by more than 0·02 mm.

**8.6 Screws** — There shall be no shift in reading due to the combined action of loosening and tightening of the locking screws.

## 9. MARKING

**9.1** Each cathetometer shall be legibly and indelibly marked with the serial number of manufacture; and name, initials or trade-mark of the manufacturer.

**9.1.1** The cathetometers may also be marked with the ISI Certification Mark.

NOTE — The use of the ISI Certification Mark is governed by the provisions of the Indian Standards Institution ( Certification Marks ) Act, and the Rules and Regulations made thereunder. Presence of this mark on products covered by an Indian Standard conveys the assurance that they have been produced to comply with the requirements of that standard, under a well-defined system of inspection, testing and quality control during production. This system, which is devised and supervised by ISI and operated by the producer, has the further safeguard that the products as actually marketed are continuously checked by ISI for conformity to the standard. Details of conditions, under which a licence for the use of the ISI Certification Mark may be granted to manufacturers or processors, may be obtained from the Indian Standards Institution.

## 10. PACKING

**10.1** The cathetometer shall be packed in fully assembled condition except the telescope. The telescope shall be packed in a suitable box with sufficient cushioning. The whole instrument shall be packed in such a manner as to prevent damage during transit.

## INTERNATIONAL SYSTEM OF UNITS ( SI UNITS )

**Base Units**

| QUANTITY | UNIT | SYMBOL |
|---|---|---|
| Length | metre | m |
| Mass | kilogram | kg |
| Time | second | s |
| Electric current | ampere | A |
| Thermodynamic temperature | kelvin | K |
| Luminous intensity | candela | cd |
| Amount of substance | mole | mol |

**Supplementary Units**

| QUANTITY | UNIT | SYMBOL |
|---|---|---|
| Plane angle | radian | rad |
| Solid angle | steradian | sr |

**Derived Units**

| QUANTITY | UNIT | SYMBOL | DEFINITION |
|---|---|---|---|
| Force | newton | N | 1 N = 1 kg.m/s$^2$ |
| Energy | joule | J | 1 J = 1 N.m |
| Power | watt | W | 1 W = 1 J/s |
| Flux | weber | Wb | 1 Wb = 1 V.s |
| Flux density | tesla | T | 1 T = 1 Wb/m$^2$ |
| Frequency | hertz | Hz | 1 Hz = 1 c/s (s$^{-1}$) |
| Electric conductance | siemens | S | 1 S = 1 A/V |
| Electromotive force | volt | V | 1 V = 1 W/A |
| Pressure, stress | pascal | Pa | 1 Pa = 1 N/m$^2$ |

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## INDIAN STANDARDS INSTITUTION

Manak Bhavan, 9 Bahadur Shah Zafar Marg, NEW DELHI 110002

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